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High density housing for foreign single graduate students in Ames: a sustainable approach

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High density housing for foreign single graduate students in Ames: A sustainable approach

by

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This is to certify that the master's thesis of

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has met the thesis requirements of Iowa State University

Signatures have been redacted for privacy

Dedication

To my mother,

And friend Silvia:

Your love inspires me everyday to be a better person.

Table of Contents

Abstract

The idea for this thesis came about mostly due to the feelings and thoughts I experienced while living by myself in different places all over Ames during the past four years. Trying to find an affordable place to live close to campus was one of my main concerns at the end of each semester and I consider this as the beginning of my thesis.

This thesis, consisting of a wide range of trends such as student preferences and sustainable architecture, explores and provides an experimental design to the student housing issue in a very personal way. One of the goals of this project is to aim at expanding the supply of residence options for foreign graduate students close to campus. Since foreign students are characterized for their dependence on mass transportation, this thesis proposes a housing option that aims at walking as primary mode of transportation and emphasizes the ISU pedestrian orientation. The proposed building design met the Development Standard requirements of the site besides adopting passive solar energy practices into the building. The result of this thesis showed that the Development Standards established by the City of Ames do not adequately meet all the needs of the students. Also, these tend to be restrictive and lead to an increase in the general cost of the project. One of the recommendations made was that the city of Ames could adjust its density requirements in the case of housing sites close to campus.

Introduction

In American universities the housing system in which students live when classes are in session is considered as important as other university facilities. In a great effort to provide a suitable educational environment and to increase student enrollment, universities are addressing their housing needs' enormous budgets and resources. Iowa State University (ISU) has directed a budget of $49 million for fiscal year 2003 (out of a total budget of $92 million assigned to the Division of Student Affairs of which the Department of Residence is a part) for renewing the housing system and hopes to reach its culmination in ten years (ISU Strategic Effectiveness and Budget Priorities 2002). These projects improve and redefine the university's image and results of these efforts can already be seen. America's Best College awarded Iowa State University's Learning Communities[1] as one of the top five in the nation.

At ISU, the Department of Residence offers housing for students from freshmen up to graduate students. Graduate students have been assigned specific types of housing: student apartments and upper division residence halls. In spite of these housing solutions that provide a reasonable environment for living and studying, graduate students choose to live outside of the university (off-campus). One of the reasons for students living off-campus is that they find more privacy in off-campus apartments.

In order to support the efforts of the Department of Residence in addressing the increasing student expectations for housing and after reviewing the students' preferences for housing, this study wants to offer another approach for the housing issue based on student expectations. In this thesis, first the expectations of housing for foreign graduate students will be identified, and then, a prototype of housing based on sustainable ideas will be proposed as a solution. The hypothesis is that

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[1] The ISU Department of Residence in its web page defines Learning Communities as "small groups of students who work closely together, each group a 'community of learners' within the larger community of the university. Students share classes, living space, and close friendships as part of an innovative program in cooperative learning."

providing this type of housing will fulfill the foreign graduate student's needs, and therefore the student's chances of succeeding. Also, it is believed that recruitment and retention of students will benefit from this project, as students would have another housing option to consider. As this project presents proximity to campus as one of its main features, a commitment to reflect the university's science and technology image is pursued. One way to accomplish this is through the use of sustainable practices that generate an environmental-friendly building. Sustainable practices applied in this building not only seek energy efficient concerns that reduce operating costs, but also demonstrate a commitment to the environment.

This thesis is directed at foreign students such as the author of this thesis, who at the end of the semester look for an affordable place to live. One of the principal characteristics of foreign students is their dependence on public transportation and their need to live close to campus, since most of them lack a car. It is believed by this author that creating housing near campus will decrease the need for commuting and emphasize the pedestrian orientation of Iowa State University. But more importantly, the simple act of creating housing in an area close to campus represents an important step toward reducing the use of energy and decreasing pollution. Inside the building the sustainable practices for delivering an environmental and energy-efficient green building are based on using passive solar practices such as site-planning[2] strategy that reduce the energy demands of the building. This prototype of student housing sets its own criteria for sustainability. Some criteria presented here are scientifically based (passive solar energy), while the other (location close to campus) reflects the subjective interpretation of the author.

[2] Burke, B in his book *The Local Government Sustainable Buildings Guide Book (1999)* on page 9 defines site-planning as green strategy "that utilizes the resource naturally available on the site, such as solar and wind energy, natural shading, and drainage."

Chapter I. Literature Review

The response and preferences of students for housing in Ames presented in this chapter will serve as a basis for the entire project. This chapter is an overview of housing options for Iowa State University students in Ames. This chapter also includes a comprehensive study of students' reaction to these housing options. The Delimiting Scopes and Similar Projects sections at the end of this chapter state clearly the intentions, trends, and goals of this thesis project.

Housing Options for Students at Iowa State University

American universities have a social function to not only teach skills, but also to promote living in society. Higher education encourages individuals to think for themselves and to communicate with others with the aim of unity and relationships through cooperation (Riker, 1956). In the universities of the United States, the residence environment supports these objectives. The residential setting then is the place out of the classroom where students learn to balance personal needs and group demands. Residential accommodations, therefore, are considered as valuable as other university buildings, such as libraries and laboratories (Butler 1922). Among the most important decisions students make after being accepted and registered in a university is without a doubt selecting the place to live when classes are in session. Students at ISU can select three options of housing: On-campus, Greek system, and off-campus housing.

On-campus housing, known as university-owned housing, is often considered the first choice to live. "9 out of 10 first-year students choose to live on-campus at Iowa State University" (ISU Department of Residence 2002). This option currently offers two types of housing to students: residence halls and student apartments. Residence halls at ISU are divided in three neighborhoods: Richardson Court Association (RCA), Union Drive Association (UDA), and Towers Residence Association (TRA). Richardson Court Association and the Union Drive Association

include traditional hall options and Fresh Start halls[3]. Towers Residence Association includes traditional hall options and special all-single room halls for upper-division students[4]. Students living in halls are provided with facilities and services such as vending areas, convenience stores, and laundry facilities. In addition, residence halls offer programs called Learning Communities, which are characterized by support services that help students improve their educational process. Besides residence halls, ISU provides student apartments in Hawthorn Court, University Village, and Schilletter Village especially for married students and upper-division students (ISU Department of Residence 2002).

In addition to university housing, there are 57 fraternity and sorority chapters on the ISU campus that housed 5 percent of the student in 1998 (ISU Student Organizations 2002).

The third option is to live off-campus. During recent years off-campus housing, considered the major housing provider for students at ISU, has become more attractive to students. Over 60 percent of the total student population currently lives off-campus (ISU Fact Book 2001-2002 Web Site).

Student Housing Overview

The data period for this thesis, 1997 to 2001, covers years of non-substantial growth for Iowa State University. From 25,385 students in 1997, the campus grew to 27,823 in 2001 (see Table 1-1). According to the Department of Residence, the total number of students living in university-owned housing in 2001 was 9,887, which was 35.5 percent of the entire ISU student population (ISU Fact Book 2001-2002). On the other hand, 13,234 students lived off-campus in 2001, including fraternities and sororities, representing 47.6 percent of the students, and 4,523 students lived outside of Ames, representing 16.3 percent of the students (ISU Fact Book 2001-2002).

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[3] Fresh Start halls, according to the ISU Department of Residence on its web page, are halls designed to meet the needs of first-year students and are offered in two halls at ISU: Maple Hall and Eaton Hall.

Table 1-1. Enrollment by Housing Type

Fall Semester Headcount and Percent

TYPE OF HOUSING	1997	1998	1999	2000	2001
University Owned					
Residence Halls	7,630	7,480	7,736	8,454	8,952
Percent	*30.1%*	*29.2%*	*29.6%*	*31.5%*	*32.2%*
University Student Apartments	1,230	1,261	981	937	935
Percent	*4.8%*	*4.9%*	*3.8%*	*3.5%*	*3.4%*
Total University Owned	8,860	8,741	8,717	9,391	9,887
Percent	*34.9%*	*34.2%*	*33.4%*	*35.0%*	*35.5%*
Off-Campus in Ames					
Fraternities and Sororities	1,575	1,515	1,464	1,492	1,565
Percent	*6.2%*	*5.9%*	*5.6%*	*5.6%*	*5.6%*
Other	10,521	10,726	11,348	11,238	11,669
Percent	*41.4%*	*41.9%*	*43.5%*	*41.9%*	*41.9%*
Total Off-Campus in Ames	12,096	12,241	12,812	12,730	13,234
Percent	*47.7%*	*47.8%*	*49.1%*	*47.4%*	*47.6%*
Outside Ames	3,405	3,396	3,424	3,691	4,523
Percent	*13.4%*	*13.3%*	*13.1%*	*13.7%*	*16.3%*
No Information	1,023	1,207	1,157	1,033	179
Percent	*4.0%*	*4.7%*	*4.4%*	*3.8%*	*0.6%*
Total University	25,385	25,585	26,110	26,845	27,823

(Source: ISU Fact Book 2001-2002)

Analyzing the information gathered and published by the Department of Residence in its *ISU Fact Book*, we draw remarkable conclusions regarding the tendency for student housing. For instance, based on "Enrollment by Housing Type" data from 1997 to 2001 the percentage of students living on-campus increased from 34.9 percent to 35.5 percent (an increase of less than 1 percent), while the percentage of students living off-campus in Ames and outside Ames in the same period of time increased from 61.1 percent to 63.9 percent. Also, the ISU Master Plan[5] has found that between 1987 and 1997 residence hall occupancy dropped 20

[4] The ISU Department of Residence on its web page refers to upper division students as students who are sophomores, juniors, and seniors.

[5] The Master Plan is a document for ISU created by Brailsford Dunlavey, Inc., in association with Bussard-Dikis and Thomas Ricca Associates, Inc. Basically, the Master Plan established strategies

percent while university enrollment dropped only 3 percent. While the university enrollment increased by 2,439 students from 1997 to 2001, the number of students living in off-campus housing grew by 1,138 in the same period of time. In other words, the private housing market housed almost 46.65 percent of the increase of the enrollment of students. Comparing 1997 and 2001, the number of students living in fraternities and sororities remained practically the same with 1,575 students in 1997 and 1,565 in 2001. This means that fraternities and sororities might be not considered as main housing providers for students.

More recently, information gathered by Donald Whalen, Coordinator of Departmental Research at ISU, shows that for Fall 2002 after ten days of classes there were 14,545 undergraduate students living off-campus and 8,701 under-graduate students living on-campus (Whalen 2002). On the other hand, there were 4,363 ISU graduate students (single and married) of which 3,680 lived in off-campus housing (Whalen 2002). It is clear that academic level affects housing selection. Students at upper levels are much more likely to live off-campus and students at lower levels are more much likely to live on-campus (Sukoff and Fink 1976). After viewing these data we could say that, in spite of ISU providing a wide range of housing solutions, it is clear that on-campus housing does not fulfill students' housing expectations. For students, the private housing market was the preferred source of housing as enrollment increased from 1997 to 2001. ISU houses an increasing number of students in its classrooms but a decreasing number of students in its housing options. Also, as the *Fact Book* shows, university-related housing such as fraternities and sororities houses played a lesser role in housing single students.

The Department of Residence and the Master Plan

The ISU Department of Residence Services oversees all of the residence halls and apartment units which are owned by ISU. Also, the Department of

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by Iowa State to improve the housing system and its facilities based on student preferences and tendencies.

Residence is responsible for placing students into housing, maintaining the living environment, and addressing all student concerns and needs regarding the housing system, thereby guaranteeing student personal growth and academic success.

In order to meet the growing student housing expectations and to support the educational mission of ISU, the Department of Residence developed a Master Plan. In this document the Department of Residence establishes strategies to improve the housing system based on student preferences and tendencies. "Planning to create neighborhoods on the ISU campus that fulfill the growing student expectations is the primary goal of the Master Plan" (ISU Department of Residence 2002). Housing projects such as Union Drive, Richardson Court, Towers, Hawthorn Court, Schilletter Village, and University Village for undergraduates and graduates are being renovated by the Department of Residence. In addition, some research is being conducted to determine the effectiveness of its actions. It is believed by the Department of Residence that improving and renovating student housing will fortify the educational environment and thereby student goals.

Delimiting the Scope

After much thought and observations of the aspects involved in the student housing issue at ISU with its great repercussions on the entire community, and considering that housing solutions are unique for each type of student (ISU Master Plan 2002), the following research questions emerged: (1) Which criteria do specific students consider when selecting their housing?; and (2) Based on the type of student, which housing design might meet their expectations? To respond to these questions, an analysis that groups characteristics of specific types of students was conducted. The source of data for such analysis was observation, surveys, and personal thought. Also, information gathered by the Department of Residence in its *ISU Fact Book 2001-2002* was used to establish a frame of reference for this thesis.

Similar Projects

Projects found in the literature incorporate a broad range of issues such as green building practices and aesthetic practices that architects have implemented in order to accomplish their buildings. These ideas have influenced this design in a direct and indirect way. The environmental goals of this thesis were established by referring to the performance of other projects with similar goals.

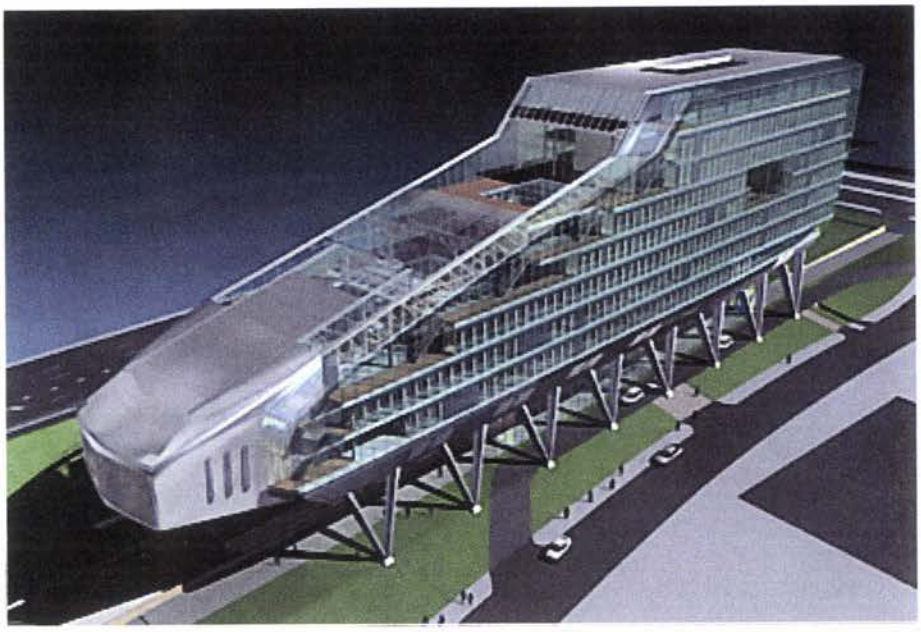
When deciding the overall building appearance, my objective was to represent the science and technology image in my design since this building is oriented to ISU students. This could be accomplished by applying sustainable practices that embody a commitment to the environment. In today's designs many clients use green designs to demonstrate a commitment to the environment and to enhance their public image (Muscoe 2000).

The International Netherlands Group (ING) gives one example of this approach of applying green concepts to demonstrate an organizational commitment to the environment (Figure 1-1). The ING building is considered to be functional as well as one of the most energy-efficient office buildings in the world. The several environmental approaches incorporated within the design make the building unique among today's architecture (Burke 1999). The major energy efficient features of this design is that the building does not use air conditioning systems and relies more on passive cooling. The building, whose sustainable strategies combine daylight spaces, energy efficient practices, and innovative concepts regarding materials, looks modern as well as green.

There are two ideas this thesis project wants to incorporate from ING Headquarters' passive solar energy strategies. First, a central atrium with solar access that receives abundant natural light, and second the high-mass structure of concrete that regulates the temperature fluctuations over the course of a day.

Figure 1-1. ING Headquarters Building Designs
(Joost van Santen http://home.planet.nl/~jvansant/ing3.htm)

At the moment ING has created a second building, which besides being energy efficiency, is also committed to promoting a healthy work environment (Figure 1-2). The building, designed by J.W. van Schooten Architects in Amsterdam, is located by one of the Holland's major highways, close to the Schipol Airport. Basically, the building provides office space to executives and staff departments of



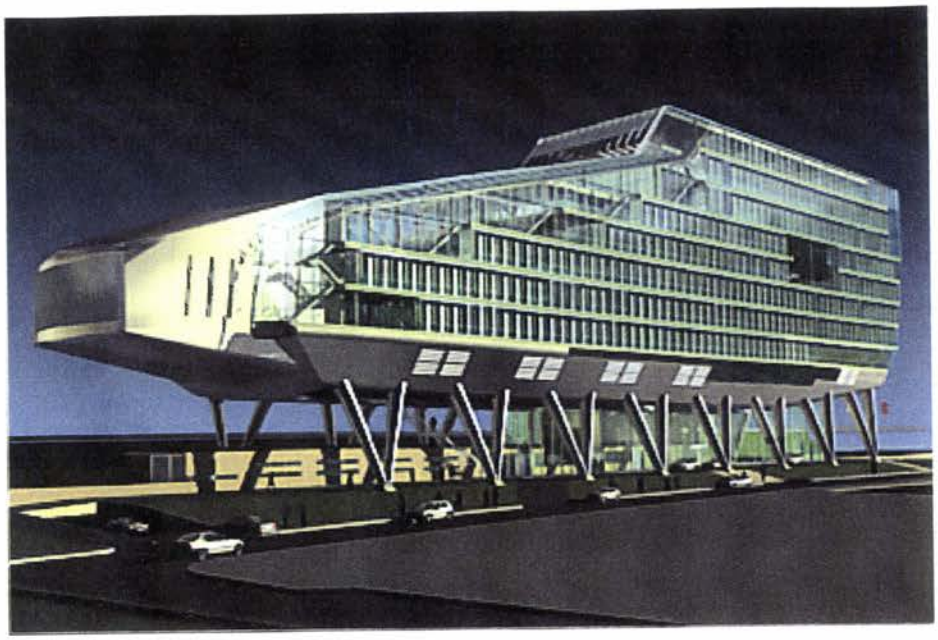


Figure 1-2. ING Office Building Design
(Meyer and Van Schooten Architects, Amsterdam http://www.meyer-vanschooten.nl/)

the ING Group. The principal feature of this building is to gain the use of daylight through a large transparent double façade, along with the use of natural materials and natural ventilation.

The Center of Regenerative Studies, sponsored by California State Polytechnic University and designed by Dougherty and Dougherty, offers an interesting sustainable approach regarding the selection of materials within the building (Figure 1-3). The selection was based not only on the materials' nontoxic, recycled, and recyclable qualities, but also on the practice of the industry that produces the materials. For example, the decking, posts, and railings use natural cedar over redwood in recognition of the cedar industry's concerns with developing renewable timber resources (Dietsch 1994). Also, interior materials avoid all synthetic products.

Figure 1-3. The Center of Regenerative Studies.
(Architecture Magazine, December 1994, p. 107)

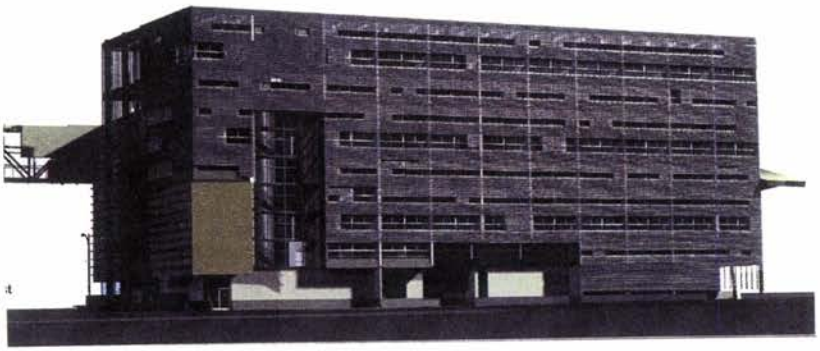


Figure 1-4. University of Toronto's graduate apartments
(Architecture Magazine, April 1999, p. 102-103)

Regarding aesthetic expression that this thesis project attempts to communicate, there is an important project to mention--the University of Toronto's graduate apartments designed by Morphosis (Figure 1-4). The attractiveness of this project is its non-conservationist image and the sense of heaviness shown by the different volumes that break with the concept of student housing.

Another important project to mention is one created by the architect Brad Cloepfil in Portland, Oregon. The building consists of a four-story cube that contributes to define the street. The side of the building that faces the main street is glass and steel mesh, while the other sides are gray slate. The building, skillfully designed, presents a railing that keeps the modern character of the building and does not attempt to break with the glassed façade.

Figure 1-5. South West façade of Cloepfil's building

(Architecture Magazine, July 2001, p. 73)

Chapter II. Sustainable Architecture

As was said in Chapter I, this thesis project came about from the interaction of trends in which sustainable architecture is a part. This chapter explains the sustainable strategies applied within the design in order to have an energy-efficient and an environmental building that reduces operating costs. This thesis advocates the use of such practices to demonstrate a commitment to the environment, and to create a functional and aesthetically pleasing building. It is fact that sustainable designs have considerable long-term values that make these ideas attractive to implement, however, it is also known that sustainable buildings need an extra investment of time and money (Muscoe 2000).

Defining Green Designs

Green designs reduce the environmental impact of a building (Talarico 1998). In architecture, to incorporate the term "green" within a building means addressing strategies that respond to environmental issues. These strategies, called sustainable strategies, have to be defined early in the design stage (Van Der Ryn and Calthorpe 1986). There are many sustainable strategies that can be applied in order to have a sustainable building. This thesis applies site planning which uses passive solar energy. It is believed that applying passive solar strategies within a building might reduce the use of mechanical systems and lower operating costs.

Passive Solar Energy

Basically, the use of passive solar strategies within a building means the use of natural environmental forces such as solar radiation to provide space heating that reduces the need for fossil-fuel-fired heating (Levy 1983). There are a number of strategies for designing a passive solar design, however this thesis adopts Direct Gain (see Figure 2-1) and Thermal Storage Wall or Trombe Wall (see Figure 2-2). Both systems are made up of three basic components: collectors, absorbers, and

storage. First, collectors are windows or clerestories with a transparent glazing located on the south-facing side of the building. Absorbers are surfaces, sometime

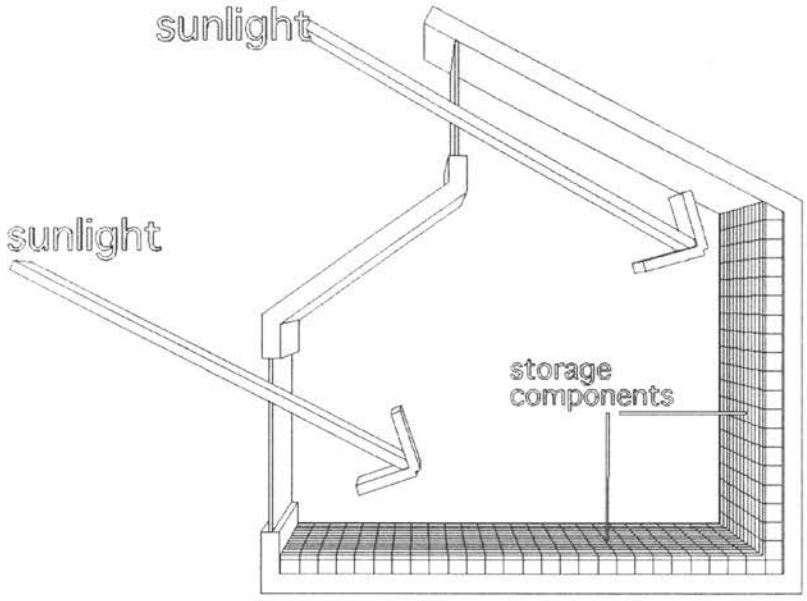


Figure 2-1. Direct Gain
(Levy 1983)

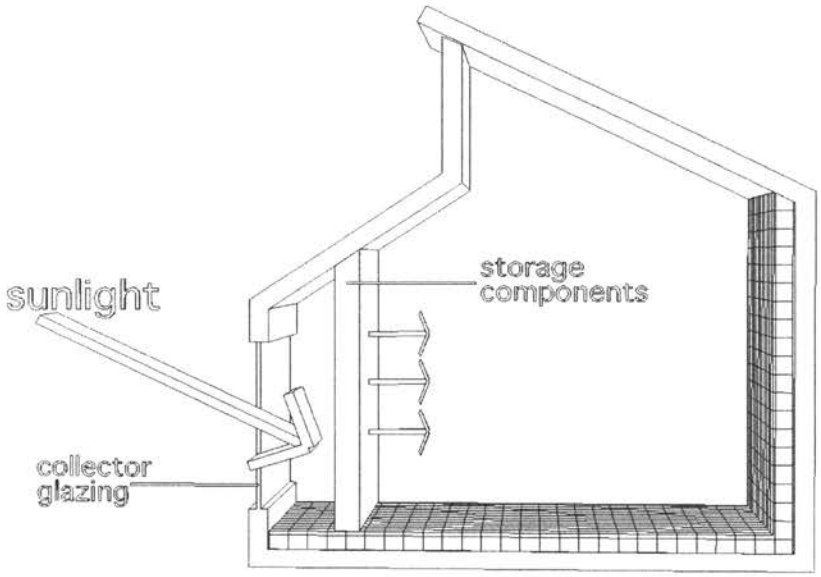


Figure 2-2. Thermal Storage Wall or Trombe Wall
(Levy 1983)

black-colored, positioned toward the sunlight entering through the collector. Storage walls convert the solar radiation into heat, retain the heat from the collector during the day, and release it overnight.

The first step to having a passive solar design is having the building oriented south to gain solar access. A logical design is to have the home laid out as a rectangle, with the long axis running east-west, so that the long side of the house faces south (see Figure 2-3). Then Direct Gain, considered the easiest passive solar strategy to implement and to construct, can rely on the collectors to allow solar radiation to enter directly and heat the living spaces without the use of any device.

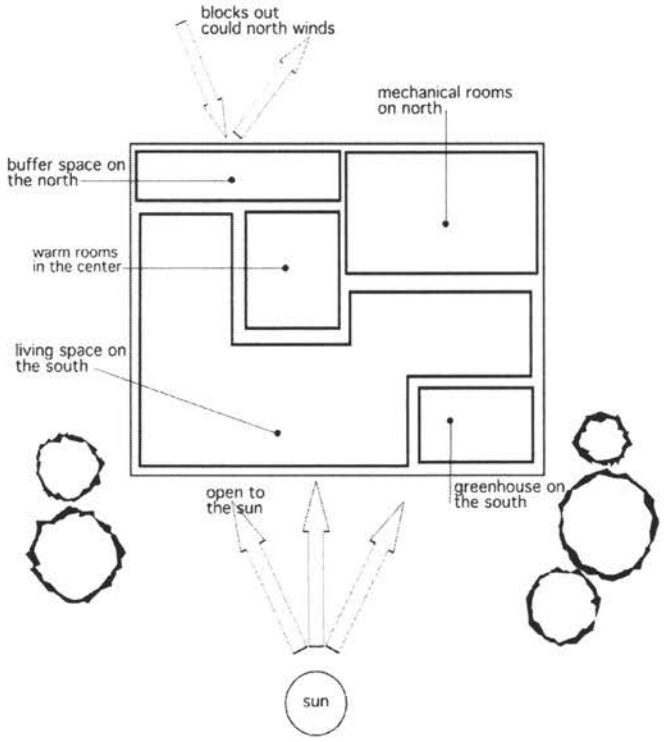


Figure 2-3. Passive Solar Orientation
(Crowther 1984)

Thermal Storage Wall, known as Trombe Wall, is characterized by having the storage component between the collector and the living space. The storage component consists of a 12-inch thick masonry wall separated from the elements by glass with air space between the wall and the glass. Basically, the way Trombe Wall works is that heat from sunlight passing through the collector glazing is absorbed by a black surface, stored in the wall, and conducted slowly inward through the masonry (Schwolsky and Williams 1982).

Since massive material increases the building's heat-retaining qualities, the use of concrete as building material is recommended in solar passive energy practices for its particular property of retaining heat from the daytime to be released during the night. There are recommendations that should be implemented when designing passive solar homes. Inside the house, rooms should be arranged to take advantage of the sun's path and match solar gain to the time of the day the room is used. Major living spaces must be oriented south. For example, kitchens and dining rooms are natural choices for the east or southeastern portion of the plan, where the rooms benefit from the early morning sun but are protected by the rest of the house from the afternoon sun (see Figure 2-3). The family room and living room lend themselves to a south or southwestern location, where the afternoon sun for evening use will warm them (Hibshman 1945). Thermal storage mass should not be covered with carpet or other materials that will reduce its storage capacity.

Benefits of Passive Solar Energy

Besides the fact that passive solar systems have considerable long-term values and reduced life cycle operating costs, the following are reasons to apply them within the design:

- It is comparatively low in cost to build.
- The passive solar system is part of the house itself and does not require electrical power.
- Direct gain is the simplest practice and the most affordable to build.

- The solar elements are incorporated into the living space.
- South-facing windows provide natural daylight and outdoor views.

Site Selection

Site selection criteria can be considered as a sustainable strategy since the main concern is to set the building close to campus allowing for pedestrian life and reducing dependence on the automobile as a mode of transportation. Among other beneficial effects resulting from this decision is the decrease of traffic congestion. This sustainable strategy reaffirms the pedestrian-oriented character of Iowa State University. Certainly, this thesis project is non-automobile oriented and aims at walking as the transportation mode to go to school. This approach might be considered as a main sustainable goal achieved by this project considering the fact that a new green building where everyone drives to work may be more detrimental to the global environment than a conventional building whose occupants use mass transit, ride bicycles, or walk (Van der Rym and Calthope 1986).

Chapter III. Architectural Program

The previous chapter discussed the sustainable practices to be applied to this design. This chapter identifies the population who this design will address, and then proposes the site as well as the type of dwelling to be created in order to suit their needs. After defining the population, site, and the type of dwelling, the Development Standards[6] as established by the City of Ames will be explained in detail and will serve as a beginning for the project.

The Project

Riker in his book *Planning Functional College Housing* (1956) noted that there is confusion in identifying the goals of student housing besides providing a place to live. He contends that before planning, needs should be defined, and having little understanding of student needs leads to failure in providing acceptable housing solutions. Therefore the first step is to define the population on which this project will be based.

All students are not alike in their housing needs. "A community that effectively meets the needs of freshmen could be very different from a community that succeeds for older students" (ISU Master Plan 2002). Therefore, to guarantee the success of this project, it is important to identify the population this thesis will address.

The uniqueness of graduate students makes us choose them among the other groups of students. First, according to Donald F. Whalen, Coordinator of Departmental Research at ISU (Whalen 2002), there are 4,363 ISU graduate students (single and married) of which 3,680 live in off-campus housing. This means that 84.34 percent of all graduate students currently live off-campus. There are just 683 graduate students living in university-owned housing (residence halls, single student Frederiksen Court apartments, and University Family Housing).

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[6] Development standards are the regulations, requirements and by-laws by which developments must abide.

They represent the highest percentage of students at ISU living off-campus compared with other students. It is clear that hall residences and apartments provided by ISU do not address the graduate students' expectations, and that students at higher academic levels are less likely to live in university residence halls or apartments and more are likely to live in private market housing. Second, single graduate students do not need structure when compared with younger undergraduate students who need more staff contact and structure to support them, such as residence assistants. This is important to take into account when we consider sites around campus where this project is more likely to take place. And finally, among single and married graduate students, single graduate students are much more flexible in their housing demands. Single graduate students can live alone or share accommodations with others or groups (Sukkof and Fink 1976). Married graduate students need more facilities and staff to support them since some have children.

Once the population for the project has been defined, their housing needs can be grouped to represent the ideas driving the project, and location should be considered one of those driving ideas. There are a number of factors that should be considered when selecting a site. First, for a single graduate student a convenient location to school is one of the first things to consider when looking for a place to stay during college life. Proximity to ISU is considered as one of the most important reasons for selecting an apartment (Chan 1999). Second, as one of the goals of this thesis is to achieve a sustainable building, there is an implicit assumption that the site must present proximity to campus for achieving energy efficient practices.

There are several identifiable factors that can be used as parameters to select the type of dwelling for single graduate students. At ISU, traditional privately-owned housing has become attractive to upper-class students. Also, as a student progress through the university, apartments became the most popular type of accommodation. These apartments are characterized as having a private atmosphere and proximity to campus as main features (Figure 3-1).

Figure 3-1. Typical Off-Campus Apartment House

After analyzing data and findings from other studies regarding student housing and after having identified the group of students as well as their needs and characteristics, this thesis explores and provides an experimental housing design in a very personal way.

West Street

West Street, located in Ames west of the ISU campus, has an east-west orientation and reflects a massing of one- to three-story townhouses and apartment buildings in combination with stores on the main level (Figure 3-2).

Figure 3-2. West Street

All the buildings are entered from West Street. Trees frame the north side of the street forming a canopy that moderates hot temperatures in the summer and shelters the pedestrians. Since there are local stores, the design attempts to emphasize the pedestrian life of the neighborhood.

Lot

The particular site to be developed in this project is lot # 0904302180. It is a vacant land and belongs to Ronal Alfred (Figure 3-3). The dimensions are 90 feet in the East and West direction and 150 feet in the North and South direction. The commercial cost is $133,500. It is essentially tabletop flat and classified under Residential High Density Zone (RH). This zone is intended to accommodate high residential developments near the university (City of Ames 2002). The development standards allow for the construction of apartment dwellings. The

definition of apartment dwellings given by City of Ames is "A dwelling containing 3 or more residential units."

Figure 3-3. Surrounding Neighborhood

The term includes what is commonly know as an apartment building, but does not include community residential facilities or single family attached dwelling. Apartment buildings may be occupied by families only, or by a group of unrelated persons limited to five or less per residential unit (City of Ames 2002).

Density

The City of Ames, through the Residential High Density (RH) Zone Development Standards, establishes that for an apartment dwelling over two units, the first two apartments require at least 7,000 square feet of the site area, and another 1,000 square feet for each additional unit (Table 3-1). Also, the minimum front and rear setbacks for the building are 25 feet from the lot line. On the other hand, the minimum side setbacks are determined by the height of the building starting with a 6 foot setback for one story buildings and adding 2 feet for each additional story. The maximum height allowed is 100 feet or 9 stories, whichever is lower, and the parking requirement is 1.5 stalls per person.

The first step is to determine the maximum tenants allowed to occupy the building (density), which is given by the amount of square feet of the site.

150' x 90' = 13,500 sq-ft.

13,500 sq-ft - 7,000 (first two units) = 6,500

6,500 sq-ft / 1,000 (for each additional unit) = 6.5 units.

6.5 units + 2 units = 8.5 units or apartment dwellings.

8.5 (apartments) x 3 (rooms) = 25.5 rooms building.

1.5 parking spaces x 25.5 (number of tenants) = 38.25 parking spaces

Within this site, a building that houses 8.5 apartments of 3 rooms each and 38 parking spaces is allowed.

Building Spaces

Parking spaces.

Main entrance.

Box mail.

Emergency exit.

Apartments.

Vestibule.

Living room

Dining.

Kitchen.

Bedrooms.

Bathroom.

Mechanical/utility.

Table 3-1. Residential High Density (RH) Zone Development Standards

(Source: City of Ames Municipal Code Web site)

DEVELOPMENT STANDARDS	RH ZONE
Minimum Lot Area Single Family Dwelling Two Family Dwelling Apartment Dwellings over 2 Units Single Family Attached Dwelling	 6,000 sf 7,000 sf 7,000 sf for the first two units and 1,000 sf each additional unit 3,500 sf per unit for the two exterior units; 1,800 sf per unit for interior units
Minimum Principal Building Setbacks: Front Lot Line Side Lot Line Side Lot Line (party wall line for Single Family Attached Dwelling) Side Lot Line (all other side lot lines except party wall line) Rear Lot Line (single family attached with party wall) Rear Lot Line (All other real yard lot lines except party wall line) Corner Lots	 25 ft 6 ft. for one story; 8 ft. for 2 stories; 10 ft for 3 stories; 12 ft. for 4 stories; 4 ft. additional for each story over 4 0 ft. 6 ft. for one story; 8 ft. for 2 stories; 10 ft. for 3 stories; 20 ft. for 4 stories 0 ft. 25 ft. Provide 2 front yards and 2 side yards
Minimum Frontage	24 ft @ street line for single family attached, all others 35 ft @ street line 24 ft @ building line for single family attached, all others 50 ft @ building line
Minimum Landscaping Apartment Dwellings	See Article 29.403(5).
Maximum Height Principal Building	100 ft or 9 stories, whichever is lower
Maximum Height Accessory Building	See Sec. 29.408(7)(a)(ii)
Drive-Through Facilities	No
Outdoor Display	No
Outdoor Storage	No
Trucks and Equipment	No

(Ord. No. 3571, 6-27-00; Ord. No. 3591, 10-10-00; Ord. No. 3595, 10-24-00)

Chapter IV. Architectural Design

The design of a student housing project on West Street represents in many aspects an experiment in which I seek to apply sustainable ideas within a site, but respect its density conditions that ultimately become the most demanding aspect of fulfilling the project. Therefore, those factors serve as the primary parameters of the project. Basically, design decisions are based on a commitment to deliver a project that achieves energy conservation. Although one of the major commitments was to design a building that uses the lowest possible consumption of energy, it is important to recognize that the major goal in architectural design is to provide spaces for human habitation.

Proposed Design

The building's aesthetic form is given by meeting the Development Standards of the site (parking requirements) and by adopting passive solar energy practices into the building (major living rooms facing south and having clerestory on the roof). Meeting the bylaw-imposed parking requirements results in a 66 foot long, 125 foot wide box with the narrowest side facing south and models itself on the edge of the setbacks, lifted 20 feet by two parking levels, plus the underground level.

The underground level is a parking area with 9 parking spaces (Figure 4-1). Then, the building is lifted by two more parking stories that together add another 29 parking spaces. The first story provides access from West Street, parking spaces, and an entrance to the building (Figure 4-2); the second story serves as parking and an entrance to the building (Figure 4-4). The third and fourth stories together house eight apartments (Figure 4-6).

The apartments are accessible via stair (Figure 4-3) as well as by an elevator, both of which are cemented in the ground level of the site and link the entire building, which seems "floating off" the ground.

Natural light coming from the south-facing clerestory at the top of the stair animates its interior. The emergency exit is on the east side of the building and lead to the second story which serves as parking. The structural alternative applied in this design is concrete columns from the base of the box (Figure 4-5).

On the outside of the project, eastern and western sides are partially covered with cedar siding, the same material that covers the front façade of the retail stores in the neighborhood, which serves as weather protection and thermal insulation and are wooden in appearance. On the other hand, the southern façade is partially covered with glass and concrete (Figure 4-8).

Inside, the building is subdivided into four apartments per story. Each apartment has three natural-lit rooms, living-dining rooms, kitchen, bathrooms and a mechanical room. There are two types of apartments:

1. Apartments with south facing living spaces to allow winter solar access to the unit in winter;
2. Apartments with east and west facing living spaces. Since those apartment configurations do not permit solar gain from south, the use of an overheating device such as south facing clerestories on the top of the stair is required to bring the sun into the unit using the staircase as the thermal mass storage for cooling and heating.

The design called for the project to be compatible and coherent with the buildings already on West Street and to maintain the scale and identity of the place rather than redefining it and standing autonomously.

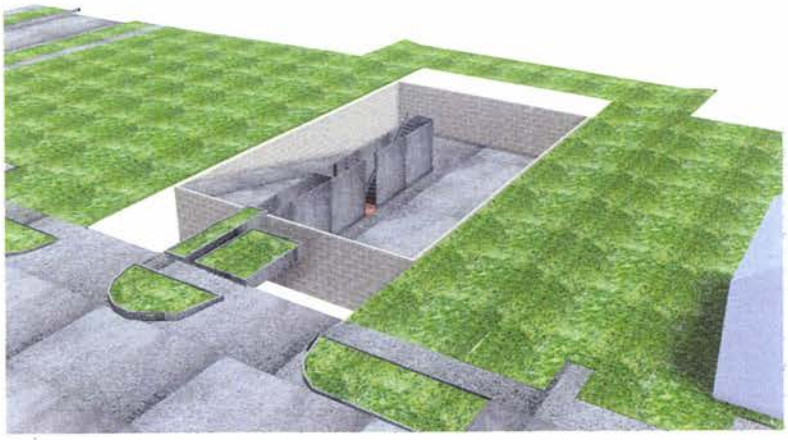

Figure 4-1. Underground Floor

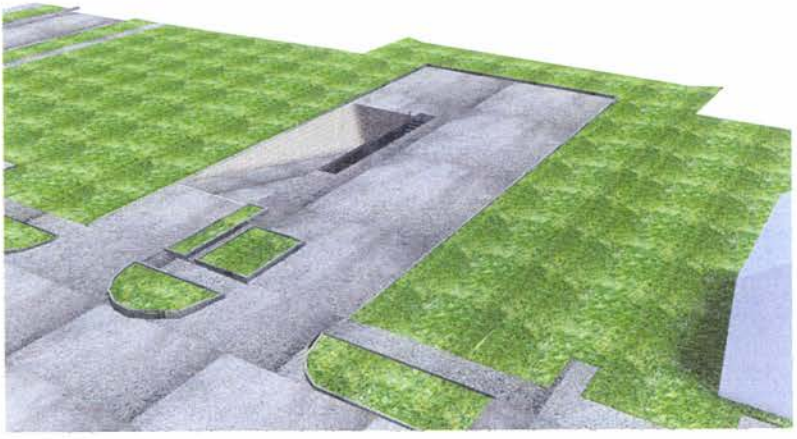

Figure 4-2. Main Floor

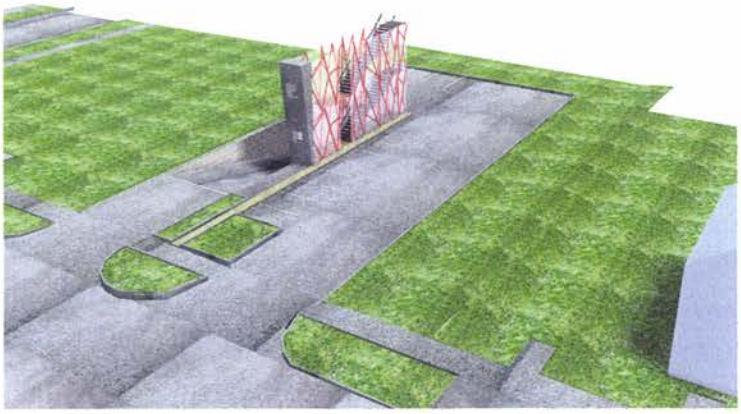

Figure 4-3. Staircase

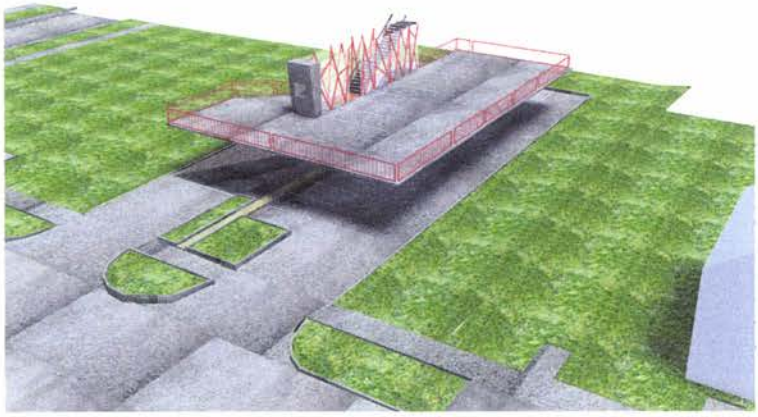

Figure 4-4. Second Floor

Figure 4-5. View of the Columns

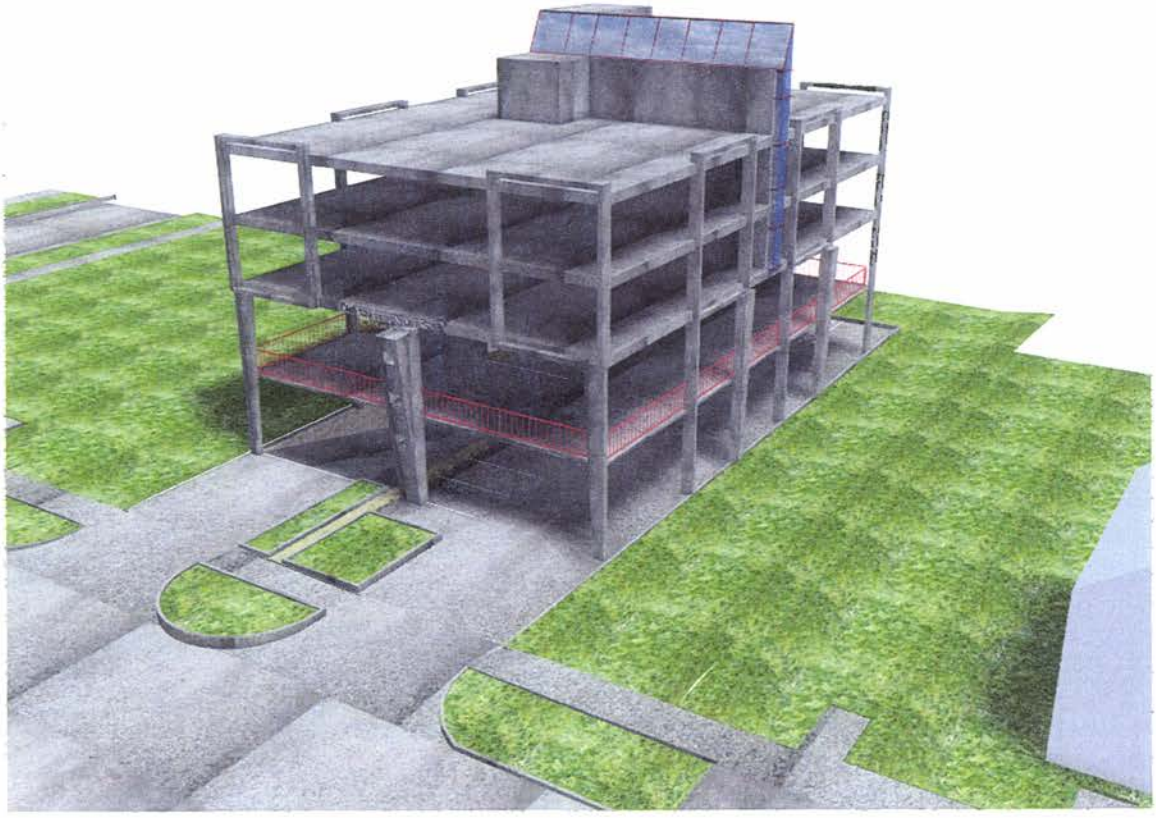

Figure 4-6. Clerestories and Apartment Floors

Figure 4-7. Aerial View

Figure. 4-8. East Façade

Figure 4-9. View from West Street

Figure 4-10. Aerial view from North Hyland

Figure 4-11. Aerial view from Campus Avenue

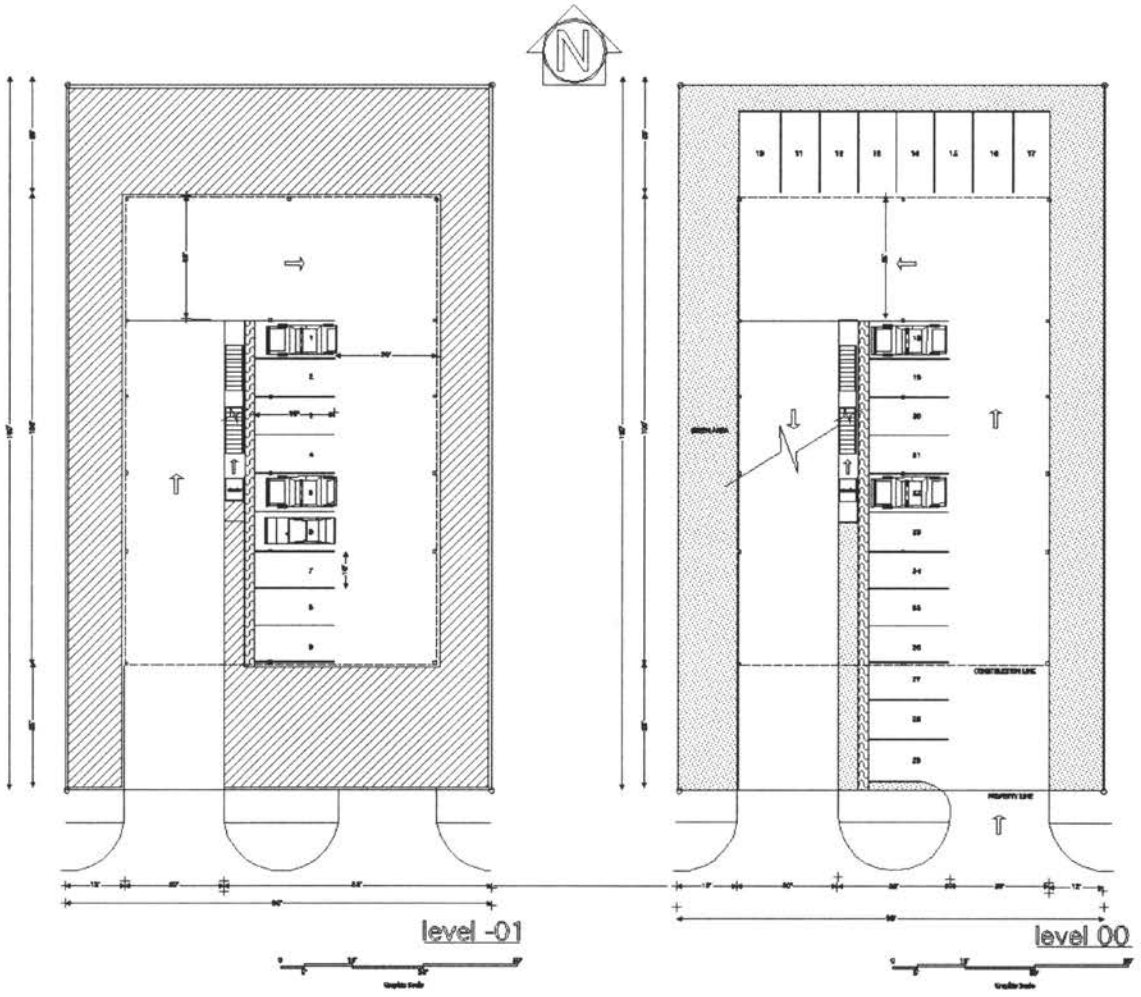

Figure 4-12. Level –01 and Level 00

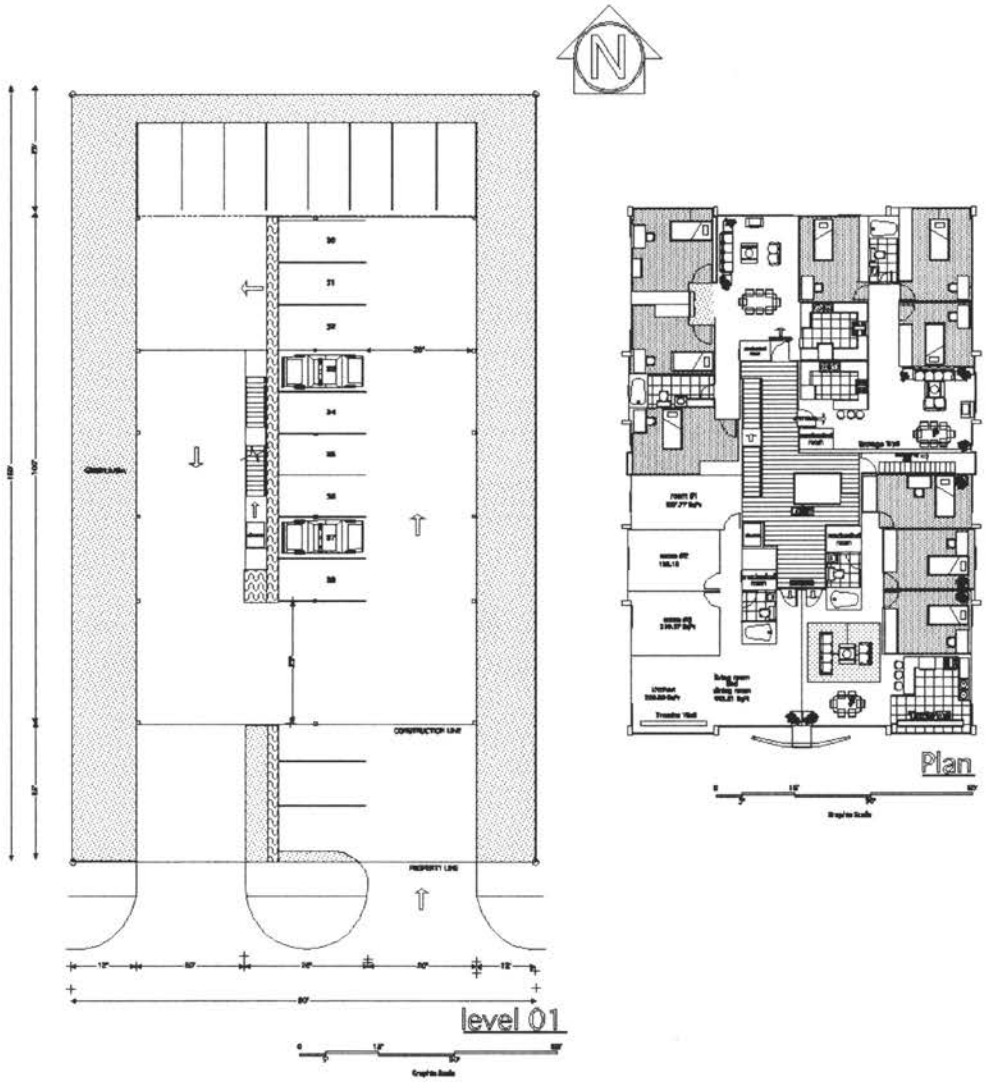

Figure 4-13. Level 01 and Apartment Plans

Conclusions

Several housing studies carried out and presented by Iowa State University show graduate student dissatisfaction toward their current living environment. Graduate students at ISU do not consider on-campus housing as their first housing option. Reasons range from lack of privacy to expensive rent. Despite the fact that the Department of Residence is now renovating the residence halls into apartments, students are more likely to move off-campus if those options better meet their housing expectations. This thesis found that students do not object to having the university as a landlord since undergraduate students often decide to live on-campus during their first years at ISU. However, it seems that they do object to the physical product the university has traditionally provided once they get comfortably acquainted with Ames. This thesis, based on student expectations and through the vehicle of a building design, demonstrates the appropriateness of green and sustainable principles and their application to specific student needs.

During this thesis project, the first step was to identify the population this study was to address. One of the reasons graduate students were selected was the large number of graduate students living off-campus and the fact that they are more flexible in their housing demands than other groups. The site selection was based on student expectations. For instance, studies carried out by the Department of Residence showed that students in general prefer to live close to campus. Also, there was an implicit assumption that the proximity of the site to campus be a main feature since this project wanted to create a sustainable design that aimed at walking as the primary mode of transportation. Regarding the type of dwelling, the traditional private apartment housing, which has become attractive to upper class students because it has a private atmosphere and proximity to campus as its main features, was selected as the option that best fulfills their needs.

The Development Standards, along with green architecture, defined the parameter of the entire design that finally resulted in a 66 foot long, 125 foot wide

box lifted 20 feet by two levels, plus the underground level. This thesis found that the Development Standards, established by the City of Ames, played an important role and had considerable control in this project's decisions. For instance, the design was originally oriented to create affordable housing for students based on low construction costs. However, including the 36 parking spaces required by the High Density Development Standards of the zone (1.5 stalls per tenant x 24 tenants) forced the building to be raised two stories, in addition to adding a basement for parking purposes. The building represents the high cost of construction since, in order to house 24 tenants, it is necessary to construct a building of five stories–three for parking and two for the apartments. Also, the underground setback requirements greatly influenced the final design. For instance, The City of Ames establishes that the underground setbacks remain similar to the setbacks of the main level. Consequently, this restricted the potential available space for parking in the underground level and forced the creation of other parking spaces on upper levels.

Since ISU is a pedestrian oriented university, the city of Ames should adjust their density requirements when sites close to campus are oriented to providing student housing. Young student tenants are not similar to adult tenants. Foreign graduate students in general do not have the financial resources of working individuals and most of them do not have a car or even think of buying one while they are students. Therefore, this thesis clearly shows that trying to meet the 1.5 parking space requirement per tenant when designing student oriented housing is unnecessary, very restrictive, and affects revenues and cost. Another issue that constrained the design even more is the setback provision. This thesis proposes another approach to establishing building setbacks. For instance, the underground setbacks might be positioned a reasonable distance from the construction line contrary to the current practice of keeping them the same distance as they are on the main level. Implementing this idea, the space available in the underground level would be maximized.

The building presented by this thesis can be considered as the best option of a design that responds to the current density requirements. Aesthetics and functionally of the building reflect the needs of foreign graduate students. Nevertheless, economically the design does not answer the needs of the tenants for whom it was created. A building of five levels which shelters just 36 persons is not economically feasible due to its high construction cost. This thesis exposes the deficiencies of the current norms of density applicable to apartments close to campus when those norms address student housing. In the future we think that the density norms should be changed to represent the necessities of the students. Alternative development standards would permit and support flexible requirements leading to more environmentally and cost-effective buildings that provide cost-savings to developers and consumers.

By implementing green building practices, this building serves as a model for the Ames community, leading the way to broaden the acceptance of green practices. For further studies, this prototype of housing and its design can still provide more ideas about other student housing solutions. The City of Ames can adjust its Development Standards in order to be more flexible when housing for students is designed. Also, the findings presented in this thesis warrant a broader audience and it is hoped that those concerned with housing issues in Ames will find this thesis useful for their purpose.

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